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Uses for Vegetable Wastes

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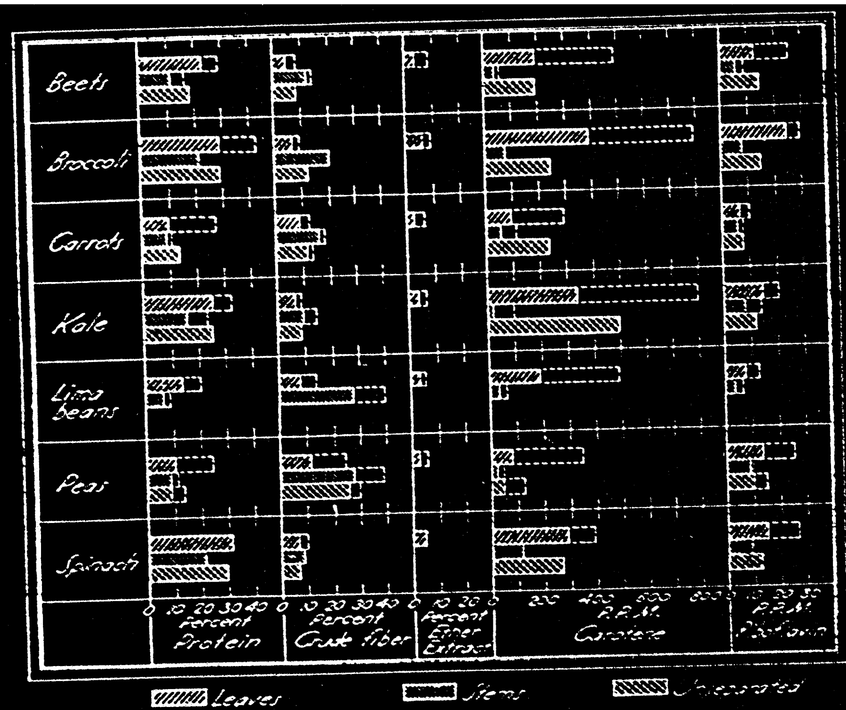
VEGETABLES are important but wasteful. Twenty-odd kinds of plants are commonly grown for vegetables in the United States. In every State they are grown commercially; the highest concentrations are in California, New York, Texas, and Wisconsin; returns from them to growers approach 300 million dollars a year. But not more than 20 to 30 percent of the crop is eaten.

The waste portions—4 million tons of them—are mostly leaves. Some wastes are left on the ground to be plowed under; some are fed; some are discarded in dumps; some are a plain nuisance; a tiny fraction is artificially dried for feed. The most conspicuous constituent of the wastes is water—about 75 to 90 percent.

One of the tasks assigned to the Eastern Regional Research Laboratory was to find further uses for vegetable crops. We found out soon enough that if any of these widely scattered, widely diverse wastes were to be utilized industrially certain conditions had to be met. The materials must contain some valuable constituents. For most uses they must be dried, partly for preservation, partly to cut down transportation costs. They must occur abundantly in a restricted area, to minimize hauling to the drier or other processing unit. A succession of wastes must be available, in order to keep a drier occupied for as long a season as possible. Two of the requisites—the chemical composition and the preparation of dried material—are technical questions, and we have directed our attention mostly to them. The others are questions of economics and have to be answered mainly by the person who is considering the exact location of a plant to use the wastes.

Because leaves are the manufacturing parts of the plant, we would expect them to be high in valuable constituents. And they are: Meal



This chart gives a general idea of the composition of various vegetable leaf wastes, on a moisture-free basis. Broccoli and spinach rank high in protein.

from alfalfa leaves is more nutritious than meal from alfalfa stems; grass leaves are highly nutritious. We therefore looked to leafy wastes as the most promising materials for study and were ultimately rewarded by being able to produce leaf meals of good quality, with high protein, high carotene, fairly high fat, and low crude-fiber contents.

At first, the leaf blades, midribs, stems, pods, and other tissues were separated by hand for chemical analysis. When it became obvious that the leaf blades were the important portion, a special drying technique and mechanical separation were devised for recovering them.

The leaf meals commonly have a protein content of 25 percent or more. Broccoli actually has reached 44 percent, which approaches that of oilseed meals. A few scattered analyses of other leaf meals show 30 percent for celery, 27 for cellards, 27 for rhubarb, and 32 for rutabagas.

Carotene, a yellow pigment that becomes vitamin A in the body, is abundant in green leaves, but is low in the less green stems. The carotene content of all these vegetable leaf meals compares favorably with that of alfalfa; in fact, considering the nature of the leaf meal and its other nutritive constituents, a carotene content of 830 International units per gram (500 parts per million in the accompanying chart) compares favorably with a fish-liver oil standardized at 4,000 I. U. And a riboflavin content of 20 parts per million is appreciable in comparison with 25 in skim-milk powder, a product used largely as a source of that vitamin.

Considering all three of these nutrients, the vegetable leaf meals show very good analyses for feed value. As one truck grower put it, "I am wondering if we humans aren't eating the wrong parts of the plants."

There is considerable range in the content of a substance in any one kind of vegetable. Most of the data we have are for vegetables grown along the Middle Atlantic seaboard. Samples from other regions might be different. In fact, the highest protein found in carrot leaves was in samples from the Florida Everglades. Dead leaves accompanying the waste reduce the values. We have noticed year-to-year variations. Within the same year, broccoli has shown a peak in protein and in carotene in August.

The proof of the pudding is in the eating. Do feeding trials confirm the chemical analyses of these leaf meals? They do, within the limits of some experiments with poultry at the Delaware Agricultural Experiment Station and at a commercial poultry farm.

A preliminary investigation on the use of dried vegetable wastes was made by substituting dried pea vine, lima bean vine, turnip, broccoli, and carrot leaf meals for the 8-percent alfalfa leaf meal in a practical all-mash broiler ration. None of the wastes had harmful effects on the birds, growth was best with broccoli and carrot diets, and feed efficiency and pigmentation were best with broccoli and turnip. Furthermore, the chicks liked the new leaf meals better than they did alfalfa.

The carotene in 3 percent of broccoli leaf meal gave as much growth as an equivalent amount of vitamin A in fish-liver oil. The broccoli imparted a deep-yellow color to shanks and skin, giving the birds a good market appearance. Although a level of 1 percent supplied sufficient vitamin A, it had to be supplemented with a little riboflavin for maximum growth.

Pea vines are abundant in several sections of the country and are already collected at the viners in great piles. Because of difficulty in obtaining a true leaf meal from them, their analyzed nutrients are lower than in other wastes, and are about equal to those of alfalfa leaf meal. In a feeding trial with chicks, the pea-vine meal was about equal to alfalfa; it was inferior one year and superior the next.

Spinach, rhubarb, and beet leaves contain appreciable amounts of oxalic acid. This acid is usually frowned on, because it may sequester calcium in feed. In actual trials with chicks, however, at levels at 2.5 to 3.8 percent of the normal basic ration, just as good growth was obtained as with 5-percent alfalfa or pea vines.

Kale and lima bean leaf meals have also been used in chick mashes with complete success.

In laying trials involving about 800 birds, 2.5 percent of broccoli leaf meal alone was substituted for the 5 percent of alfalfa leaf meal and 0.5 percent of fish-liver oil in the controls. Slightly higher egg production was obtained with the broccoli mash over a 3-month period. In hatching experiments, nearly equal hatches were obtained when 2.5 percent of broccoli and 0.5 percent of fish-liver oil were substituted for 5 percent of alfalfa and 1 percent of fish-liver oil.

We can conclude, then, that these leaf meals are satisfactory supplements to chicken feed, whether for growing, laying, or hatching. They have not been tried on other poultry or on other farm animals.

The Drying Process

Obviously the first thing to be done in preparing a leaf meal is to dry the leaves. In the method of fractional drying developed at the Eastern Regional Research Laboratory, in Philadelphia, the thin and more valuable leaf-blade portion dries much more rapidly than the thicker and less valuable midribs and stems. To take advantage of these factors, the leaves are dried rapidly to the point where the blades are brittle but the stems and midribs are still tough. The material is immediately fed into a hammer mill having no screen. This breaks the brittle leaves loose from the stems. The two fractions are then separated in a current of air adjusted to blow the leaf fraction away from the heavier stems. The process is about 95 percent efficient. The wet stems can be discarded, or they can be crushed and dried separately to give a less valuable product.

In final pilot-plant studies a triple-belt, continuous drier was used. In it the air is circulated at high velocity downward through each belt individually. It is equipped for control of wet- and dry-bulb temperature, air velocity, and percentage of air recirculated. Experiments showed the following conditions to be best for this type of drier: Inlet air temperature of 240° F., rapid circulation of air through the bed of material at a rate of 175 cubic feet a minute per square foot of bed, a light loading on the first belt and heavier loading on the successive belts, and agitation of the material as it falls from one belt to the next to break up any lumps. The permissible load on the first belt varies with the kind of waste.

The actual size of the drier required would naturally depend on the quantities of waste available and hourly capacities desired, but for the purpose of general discussion and comparison of capacities for different wastes, a drier having a total drying area of 930 square feet has been selected. It would have an hourly production rate of from 300 to 1,200 pounds of dry, separated leaf meal, depending upon the waste being processed. With a belt 8½ feet wide, a three-belt multiple-deck drier with this drying area would be approximately 40 feet long. A hammer mill that could handle approximately 1 ton an hour would take care of the drier output. The material then goes to an air separator consisting of a fan and large diameter pipes so arranged that the leaf fractions are discharged at the top through a cyclone separator and the stems come out at the bottom. The cleaned leaf material is then ground in a hammer mill to produce the final meal.

Waste lettuce, citrus pulp, and tomato skins and seeds are now being artificially dried for feed. In the Everglades section of Florida, where a large variety of vegetable materials are grown over a long season, utilization of waste for feeds is proving practical. Drying equipment is already installed for preparing feeds from sweetpotato vine (sweetpotatoes are grown in large quantities for the production of starch), ramie tops, which are removed before processing the plants for fiber, and a special kind of grass from which lemon oil is distilled. Machine-dried alfalfa is commonplace. Can some of the vegetable wastes we have mentioned join the ranks?

The tonnage of wastes is tremendous. Some are already accumulated in great quantities at viners and packing sheds; others could easily be harvested mechanically, as is now done with sugar-beet leaves. Their seasonal span is favorable (beginning in June with peas, followed by various vegetables throughout the summer, lima beans in September, and broccoli in October and November). A highly nutritious leaf meal can be prepared from a number of them; they are relished and well utilized by poultry, at least. The mechanics of the drying and separating have been worked out. The over-all cost of the final leaf meal will vary with the different materials from $22 to $95 a ton.

The commercial feasibility of the proposition depends largely on two questions: Can exact locations be found where sufficient wastes are readily available for a sufficient number of successive weeks to keep the operating costs to a minimum? And will the consumer pay for the real worth of these meals, considering at least their content of protein, carotene, and riboflavin? We believe the answer to both questions is yes.

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FOR FURTHER READING

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